CLAIMS

1. An electrostatic suction type fluid discharge device, in which drive voltage supply means supplies a drive voltage between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target,

the hole of the nozzle falling within a range between $\varphi 0.01\mu m$ and $\varphi 25\mu m$ in diameter, and

the drive voltage supply means outputting, as the drive voltage, a bipolar pulse voltage which alternates between positive and negative and has a frequency of not less than 1Hz.

2. An electrostatic suction type fluid discharge device, in which drive voltage supply means supplies a drive voltage between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target,

the hole of the nozzle falling within a range between $\varphi 0.01\mu m$ and $\varphi 25\mu m$ in diameter, and

the drive voltage supply means outputting, as the drive voltage, a bipolar pulse voltage which alternates between positive and negative and satisfies $f \leq 1/(2\tau)$ where τ is a time

constant determined by $\tau=\varepsilon/\sigma$, f is a drive voltage frequency (Hz), σ is an electric conductivity (S/m) of the discharge fluid, and ε is a relative permittivity of the discharge fluid.

3. An electrostatic suction type fluid discharge device, in which drive voltage supply means supplies a drive voltage between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target, and the nozzle and the discharge target are moved in a relative manner by shifting means, in a direction orthogonal to a direction along which the nozzle and the discharge target oppose to each other,

the hole of the nozzle falling within a range between $\varphi 0.01\mu m$ and $\varphi 25\mu m$ in diameter,

the drive voltage supply means outputting, as the drive voltage, a bipolar pulse voltage which alternates between positive and negative and has a frequency of fHz, and

the electrostatic suction type fluid discharge device further comprising control means that controls at least one of the drive voltage supply means and the shifting means in such a manner as to satisfy $f \geq 5v$ where f is a drive voltage frequency (Hz) of the drive voltage supply means and v indicates a relative speed (μm/sec) of the relative movement of the nozzle and the discharge target.

4. An electrostatic suction type fluid discharge device, in which drive voltage supply means supplies a drive voltage between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target, and the nozzle and the discharge target are moved in a relative manner by shifting means, in a direction orthogonal to a direction along which the nozzle and the discharge target oppose to each other,

the hole of the nozzle falling within a range between $\varphi 0.01\mu m$ and $\varphi 25\mu m$ in diameter, and

the drive voltage supply means outputting, as the drive voltage, a bipolar pulse voltage which alternates between positive and negative and is not more than 400V.

5. An electrostatic suction type fluid discharge method, in which a drive voltage is supplied between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target,

the hole of the nozzle falling within a range between $\varphi 0.01\mu m$ and $\varphi 25\mu m$ in diameter, and

the drive voltage being a bipolar pulse voltage which alternates between positive and negative and has a frequency of

not less than 1Hz.

6. An electrostatic suction type fluid discharge method, in which a drive voltage is supplied between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target,

the hole of the nozzle falling within a range between φ0.01μm and φ25μm in diameter, and

the drive voltage being a bipolar pulse voltage which alternates between positive and negative and satisfies $f \leq 1/(2\tau)$ where τ is a time constant determined by $\tau = \varepsilon/\sigma$, f is a drive voltage frequency (Hz), σ is an electric conductivity (S/m) of the discharge fluid, and ε is a relative permittivity of the discharge fluid..

7. An electrostatic suction type fluid discharge method, in which a drive voltage is supplied between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target, and the nozzle and the discharge target are moved in a relative manner, in a direction orthogonal to a direction along which the nozzle and the discharge target oppose to each other,

the hole of the nozzle falling within a range between

φ0.01μm and φ25μm in diameter,

as the drive voltage, a bipolar pulse voltage which alternates between positive and negative and has a frequency of fHz being outputted, and

at least one of the drive voltage frequency fHz and a relative speed vμm/sec of the relative movement of the nozzle and the discharge target being controlled in such a manner as to satisfy $f \geq 5v$.

8. An electrostatic suction type fluid discharge method, in which a drive voltage is supplied between a nozzle and a discharge target and hence an electric charge is applied to a fluid supplied into the nozzle, so that the fluid is discharged from a hole of the nozzle to the discharge target,

the hole of the nozzle falling within a range between φ0.01μm and φ25μm in diameter, and

the drive voltage being a bipolar pulse voltage which alternates between positive and negative and is not more than 400V.

9. An electrostatic suction type fluid discharge device that (i) discharges, by electrostatic suction, a discharge fluid through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) causes the discharge fluid to land onto a

substrate, (iii) so as to form a drawing pattern by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter, and

the substrate being insulating,

the electrostatic suction type fluid discharge device comprising:

charge removal means for removing an electric charge on the surface of the substrate, before the discharge fluid is discharged onto the substrate; and

fluid discharge means for discharging, by a positive and negative bipolar pulse voltage, the discharge fluid onto the substrate from which electricity has been removed.

10. The electrostatic suction type fluid discharge device as defined in claim 9, wherein, the charge removal means removes the electricity on the substrate, in line with a predetermined pattern.

11. The electrostatic suction type fluid discharge device as defined in claim 9, wherein, the fluid discharge means discharges the discharge fluid by applying a voltage which is arranged such that an electric field strength generated by electric charge concentration at a meniscus part, when discharging the discharge fluid, is smaller than a discharge

start electric field strength figured out by an equation for calculating Paschen curve.

12. The electrostatic suction type fluid discharge device as defined in claim 11, wherein, the voltage applied when the fluid discharge means discharges the discharge fluid is not less than 340V.

13. The electrostatic suction type fluid discharge device as defined in claim 11, wherein, the fluid discharge hole of the nozzle is not less than 16μm or not more than 0.25μm in diameter, and the voltage applied when the fluid discharge means discharges the discharge fluid is not more than 500V.

14. The electrostatic suction type fluid discharge device as defined in claim 11, wherein, the fluid discharge hole of the nozzle is not less than 7.4μm or not more than 0.65μm in diameter, and the voltage applied when the fluid discharge means discharges the discharge fluid is not more than 400V.

15. An electrostatic suction type fluid discharge method in which (i) by electrostatic suction, a discharge fluid is discharged through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) the discharge fluid is caused to

land onto a substrate, (iii) so that a drawing pattern is formed by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter, and

the substrate being insulating,

an electric charge on the surface of the substrate being removed, before the discharge fluid is discharged onto the substrate, and

by a positive and negative bipolar pulse voltage, the discharge fluid being discharged onto the substrate from which electricity has been removed.

16. An electrostatic suction type fluid discharge device that (i) discharges, by electrostatic suction, a discharge fluid through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) causes the discharge fluid to land onto a substrate, (iii) so as to form a drawing pattern by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter, and

the substrate being insulating,

the electrostatic suction type fluid discharge device comprising:

electric charge providing means for providing an electric

charge to a surface of the substrate, in line with a predetermined pattern.

17. The electrostatic suction type fluid discharge device as defined in claim 16, wherein, the electric charge providing means provides the electric charge to an insulating substrate made of a photoconductive material,

the electric charge providing means including:

uniform electric charging means for uniformly charging the surface of the insulating substrate; and

charge removal means for applying, in line with a predetermined pattern, a laser beam to the surface being uniformly charged, so as to remove electricity from a part of the surface where the laser beam has been applied.

18. An electrostatic suction type fluid discharge device that (i) discharges, by electrostatic suction, a discharge fluid through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) causes the discharge fluid to land onto a substrate, (iii) so as to form a drawing pattern by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter, the substrate being insulating, and,

the electrostatic suction type fluid discharge device comprising:

voltage application means that is capable of touching the insulating substrate on which a pattern of a conductive material is formed and that applies a voltage to a conductive part on the insulating substrate, when the electrostatic suction type fluid discharge device discharges the discharge fluid.

19. A plot formation method using an electrostatic suction type fluid discharge device that (i) discharges, by electrostatic suction, a discharge fluid through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) causes the discharge fluid to land onto a substrate, (iii) so as to form a drawing pattern by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter,

the substrate being insulating,

before the discharge fluid is discharged, an electric charge, whose polarity is in reverse to a polarity of a drive voltage by which the discharge fluid is electrically charged in advance, being applied to a part of the insulating substrate where a drawing pattern is to be formed, so that an electric charge pattern is formed, and

the drawing pattern being formed by the discharge fluid, by discharging the discharge fluid on the electric charge pattern.

20. A plot formation method using an electrostatic suction type fluid discharge device that (i) discharges, by electrostatic suction, a discharge fluid through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) causes the discharge fluid to land onto a substrate, (iii) so as to form a drawing pattern by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter,

the substrate being insulating,

before the fluid is discharged, an electric charge, whose polarity is identical with a polarity of a drive voltage by which the discharge fluid is electrically charged in advance, being applied around a part on the insulating substrate where a drawing pattern is to be formed, so that an electric charge pattern is formed, and

the drawing pattern being formed by the discharge fluid, by discharging the discharge fluid onto a drawing pattern formation area which is surrounded by the electric charge pattern.

21. The plot pattern formation method as defined in claim 20, wherein, the electric charge pattern is formed in such a manner that, after a surface of the insulating substrate is electrically charged in a uniform manner, a laser beam is applied to the uniformly-charged surface in line with a predetermined pattern, and electricity is removed from a part where the laser beam has been applied.

22. A plot formation method using an electrostatic suction type fluid discharge device that (i) discharges, by electrostatic suction, a discharge fluid through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) causes the discharge fluid to land onto a substrate, (iii) so as to form a drawing pattern by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter,

the substrate being insulating,

before the discharge fluid is discharged, an electric charge, whose polarity is identical with a polarity of a drive voltage by which the discharge fluid is electrically charged in advance, being applied to a non-image-drawing area where a drawing pattern is not to be formed on the insulating substrate, so that

an electric charge pattern is formed, and

the drawing pattern being formed while the voltage applied for discharging the discharge fluid is not stopped even on the non-image drawing area.

23. A plot formation method using an electrostatic suction type fluid discharge device that (i) discharges, by electrostatic suction, a discharge fluid through a fluid discharge hole of a nozzle of a fluid discharge head, the discharge fluid being electrically charged by voltage application, and (ii) causes the discharge fluid to land onto a substrate, (iii) so as to form a drawing pattern by the discharge fluid on a surface of the substrate,

the fluid discharge hole of the nozzle falling in a range between 0.01μm and 25μm in diameter,

the substrate being insulating, and

in a case where a first drawing pattern made of a conductive material has been formed by a conductive material on the insulating substrate and a second drawing pattern is further formed on the first drawing pattern, the second drawing pattern being formed while a voltage is applied to the conductive part by which the first drawing pattern is made.